# A CASE STUDY: FINAL EXAM VERSUS CONTINUOUS ASSESSMENT MARKS FOR ELECTRICAL AND ELECTRONIC ENGINEERING STUDENTS

**J. C. G. de Sande, L. Arriero, C. Benavente, R. Fraile, J. I. Godino-Llorente, J. Gutiérrez, D. Osés, V. Osma-Ruiz**
E.U.I.T.T., Universidad Politécnica de Madrid
Madrid/Spain
*jcgsande@ics.upm.es*

## Abstract

In this work we analyze the final marks obtained by the students of the course "Signals and Systems" of the Electrical and Electronic Engineering degree at the E.U.I.T. de Telecomunicación in the Universidad Politécnica de Madrid. Students within this course are assessed by two different methods: the first one consists of only a final exam while the second one implies students following a continuous and formative assessment method in which they are required to solve some open exercises almost every week and to fulfil a self-evaluation test every two weeks all along the whole semester. During the academic year 07/08, all the students of the course were assessed by both methods. Herein, we analyze the final marks (in a 0-10 scale) obtained by the students and compare the pass and fail rates obtained with both assessment methods when the minimum mark for passing is set to 5.
This work was done with a sample of 210 students that were divided in 7 different groups with different lecturers. We have found that more than 70 % of the students where classified in the same group, either pass or fail, with both assessment methods. As for the rest, 15 % of the students failed with the continuous assessment method but succeeded in the final exam and the remaining 15% passed in the continuous assessment and failed in the finals. For these two groups, observations indicate that the first one corresponds to students that either deliberately chose to be evaluated only with a final exam, thus not presenting the required coursework, or presented medium quality works (marks around 4) and did a greater effort for preparing the exam. As for the last group, it should be highlighted that their effort during the course allowed the majority of them to obtain marks above 3.5 points in the final exam.
Based on these results, we made simulations so as to have an insight in what would be the student's final marks when both assessment methods were combined with different weightings. Nowadays, this kind of combination is a common practice in many Universities, but usually the final exam has a higher weight (60 to 80 %) in the final student's marks. We found that even if the final exam's weight was only 25% and the continuous assessment's weight was 75%, only 3% of the students that had final exam marks lower than 3.5 would obtain a weighted mark over 5.0. Consequently, we conclude that continuous assessment gives practically the same pass/fail rates as the final exam.

## Keywords
Continuous assessment, final exam, formative evaluation.

## 1. INTRODUCTION
Many lecturers are convinced that the assessment of student performance should be integrated with a dynamic learning-and-teaching process and not separate from it. However, it is a common practice in universities to use a summative assessment, where the main objective is judgement, instead of using formative assessment where the main objective is learning. Some authors have pointed out that "… *there is evidence of a drift back to reliance on exams*" [1], as many of those who nowadays evaluate students do so in the same way as they were assessed when being students. Coherently, sentences like "*A final examination shall be given in every undergraduate course*" can be read in the grading and examination policies of most universities.
In parallel, European universities are involved in the development of the European Higher Education Area and one of the specific objectives of such action is the adoption of a compatible credit system, the ECTS (European Credit Transfer System) [2]. ECTS credits can only be obtained by the students after the successful completion of the work required on their courses and passing the assessment of the achieved learning outcomes. These learning outcomes are defined as sets of competences which refer to what the student should know, understand or be able to do after ending his or her learning

process, independently of its duration [3]. In this framework, many lecturers are adopting and adapting different methods for the evaluation of competences, but a final exam weighted around 75 % of the final student mark is still common [4].
Arguments against the adoption of assessment methods based on projects, problems, classroom or home work, individual or team work, self-tests, etc, or even a combination of these methods, are usually based on the difficulty to control plagiarism between students. It is argued that with these evaluation schemes some students could obtain high marks without learning almost anything about the subject under study or, in other words, without acquiring the required competences. From this point of view, some lecturers defend the necessity of a final exam that counts at least 75% of the final marks. The herein reported experiment was intended to determine if the actual behaviour of students provides a basis for these fears or not. Specifically, we studied the proportion of students that obtained high marks when following a continuous assessment method but failed in a final exam when these students are assessed by both methods. The context for the study was the course "Signals and Systems" that belongs to the "Electrical and Electronic Engineering" degree at the E.U.I.T. de Telecomunicación in the Universidad Politécnica de Madrid.
In the following section both assessment methods are described. In the third section we present the results obtained in the comparison of both methods. Additionally we show the results of simulating different weighed combinations of both methods to grade the students. Finally, in section four we report on the conclusions about the comparison of both assessment methods.

## 2. DESCRITION OF THE ASSESSMENT METHODS

"Signals and Systems" is a compulsory course in the studies of the Electrical and Electronic Engineering degrees in most Universities. In our institution, this course is set as a semester course in the second academic year of the grade. Traditionally, students undertaking this course have been assessed by means of a final exam. At the beginning of the academic year 2007-08, students involved in the present study were informed that an alternative continuous evaluation method would be offered to those students that wanted to follow it and that the mark of such continuous evaluation would count 25% of the final mark while the rest would be obtained through the traditional finals. Alternatively, the final exam was maintained as the single assessment procedure for students that either did not follow the continuous evaluation or obtained a mark in the continuous evaluation below the value of the exam marks.
Students were divided in 7 different groups, each group was assigned to one of the 7 lecturers that participated in the experiment. 210 students made the final exam at the end of the semester. Most of these students attended some classes and followed, at least partially, the continuous evaluation process. We used a 0-10 scale for grading the results of the students both in every part of the continuous evaluation and in the final exam. For passing the course, students had to achieve a minimum mark of 5 points after the above-mentioned weighting procedure.

### 2.1 Continuous evaluation

Continuous evaluation consisted of two different parts: the first one corresponded to open exercises in the classroom and homework; the second one consisted of individual tests, performed in a Web self-assessment tool, using Moodle [5] . In what follows we describe both parts.
For the first part of the continuous evaluation, all lecturers tried along the semester to involve their students in doing short exercises and sharing the results both in small groups and in the whole group using the blackboard. The review of these exercises usually have corresponded to the students themselves who interchanged their exercises and graded them. We noticed that, in these cases, students tend to be as hard as the lecturers, sometimes even harder, when grading the work of their classmates. So the responsibility for grading is shifted to the students, thus making them active participants in the evaluation process. Different methods to improve the validity of this peer assessment activity and to promote teamwork abilities [6] were incorporated. The open exercises part consisted of problems similar to those of the final exam but shorter, containing only one or two sections, to be solved in about twenty minutes or less. In tables 1, 2 and 3, we present examples of these exercises.

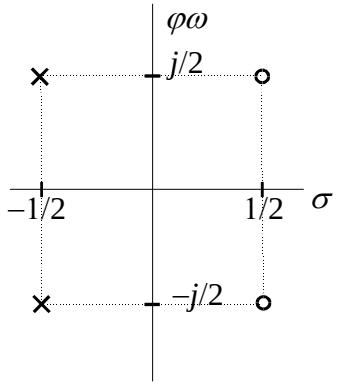
Given a discrete-time LTI system described by the following difference equation:

$$y[n] = x[n] + \frac{3}{4}x[n-2] - \frac{1}{4}x[n-4]$$

a) Obtain the output when the input is $x[n]=\delta[n]$.
b) The original system is connected in series with a system defined by the system function $H_1(z) = \frac{1}{1+2z^{-1}+2z^{-2}}$, $ROC = \left\{ |z| > \sqrt{2} \right\}$ . Determine the frequency response of the connexion.

Table 1: Example of an open problem with low difficulty.

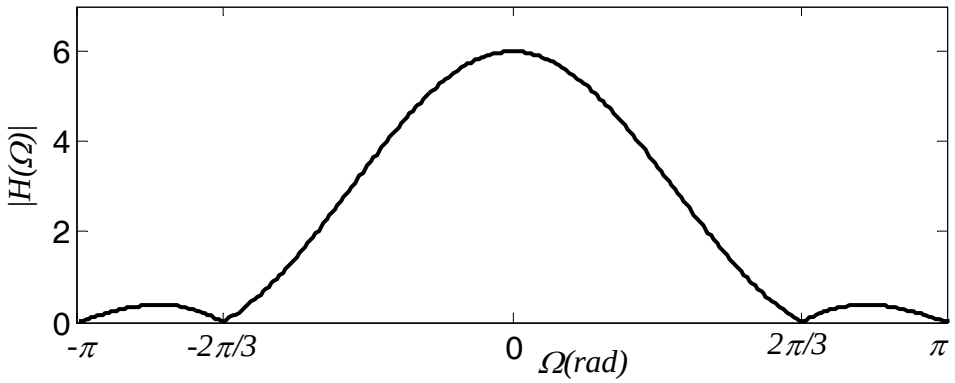
The following pole-zero diagram corresponds to an LTI continuous-time system.




a) Assuming that $H(s=3)=1$, determine the frequency response of the system and draw approximately the corresponding magnitude.
b) Find $h(t)$

Table 2: Example of an open problem with medium difficulty.

The magnitude of the frequency response corresponding to a FIR causal filter is plotted below for $-\pi<\Omega<\pi$.




a) Find the system function $H(z)$.
b) Determine the output when the input is $x[n]=\tilde{(}1)^n$.

Table 3: Example of an open problem with a high degree of difficulty.

The second part of the continuous evaluation was based on multiple-choice tests covering the contents of every chapter. Though negative experiences about using Web self-assessment tools have been reported [7], we remark that these tests were only a relatively small part of the overall evaluation

process. Tests consisted of ten items to be classified as either true or false via Web using the Moodle platform. No time limits are imposed to complete the full test so, students could think carefully before answering the questions. Taking into account that the quality of the item bank affects decisively the final results of the test, we examine the answers [8] in order to measure the degree of difficulty of the questions. These results permit us to assign the items properly, when constructing the final test sheet, in order to meet the assessment requirements. An advantage of the Moodle based platform is that the students get immediate feedback from their choices and correct and incorrect answers are highlighted. Different examples of test items, classified according to the degree of difficulty, can be seen in tables 4, 5, and 6.

In order to obtain the continuous evaluation mark for each student, we used the following weights: 20% for the tests and 80 % for the class and home short exercises

| | T | F |
|---|---|---|
| A linear feedback system is always stable. | ☐ | ☐ |
| If $h(t)=t\cdot\tilde{u}(t)$ is the impulse response of an LTI system, then the system is stable . | ☐ | ☐ |
| If $x(t)=\cos(t)+\sin(t)$, the corresponding Fourier Series coefficient $a_0$ is $a_0=1+1=2$. | ☐ | ☐ |
| The signal $x[n]=\exp(j2n/25)$ is periodic. | ☐ | ☐ |
| $H(z)=\tilde{z}^{1}$ can correspond to a memoryless system. | ☐ | ☐ |
| If we know the impulse response of a certain system, we can always determine the response corresponding to any other input. | ☐ | ☐ |
| The frequency response of any continuous-time LTI system is periodic with period $2\pi$. | ☐ | ☐ |

Table 4: Examples of test items considered of low difficulty degree

| | T | F |
|---|---|---|
| $x[n]=\sin(2\pi n/5)$ can be delayed in $\frac{2}{5}$ time units. | ☐ | ☐ |
| The system function corresponding to a discrete-time LTI system has no poles. | ☐ | ☐ |
| The input-output relation $y[n]=x[n]+2x[n-1]+3$ describes an LTI system. | ☐ | ☐ |
| If the transfer function of an LTI system is $H(z)=1+z^{-2}$ for $\lvert z\rvert>0$, we can say that such system is FIR, stable, causal, and its frequency response $H\left(e^{j\Omega}\right)=0$ for $\Omega=\frac{\pi}{2}$. | ☐ | ☐ |
| If $H(s)=\frac{s^2-1}{s^2-2}$, $\Re e\{s\}>\sqrt{2}$, then $h(t)=u(t)+\cos(2t)u(t)$. | ☐ | ☐ |
| The Laplace transform of $x(t)=u(t)\delta(t-2)$ is $X(s)=\frac{1}{s}\exp(-2s)\quad\forall s$. | ☐ | ☐ |
| If a system has the response $y(t)=3\sin(\omega t)$ to the input $x(t)=\sin(\omega t)$, we can guarantee that the system is linear. | ☐ | ☐ |

Table 5: Examples of test items considered of medium difficulty degree

| | T | F |
|---|---|---|
| The Discrete-Time Fourier Transform of a sequence $x[n]$ can be periodic with period $\frac{\pi}{4}$. | ☐ | ☐ |
| The signal $x(t)=\begin{cases} 2t \text{ for } 0<t\le 10^{-3} \text{ s} \\ \text{Periodic with period } 10^{-3} \text{ s} \end{cases}$ can be sampled without aliasing if the sampling frequency is greater than 2kHz. | ☐ | ☐ |
| For a discrete-time LTI system whose impulse response is real and $H\left(e^{j\Omega}\right)=0$ for $\Omega=\frac{\pi}{2}$, we can assure that $H(z)=0$ for $z=-j$. | ☐ | ☐ |
| If $x(t)=t[u(t-1)-u(t-2)]$ and $y(t)=x(t)*x(t)$, it holds that $y(1)=y(5)$. | ☐ | ☐ |
| A continuous-time LTI system, for which the ROC associated to its system function is the region in the s-plane to the right of the rightmost pole, is always causal. | ☐ | ☐ |
| $H\left(\mathrm{e}^{j\Omega}\right)=\frac{2\sin(3\Omega)}{\Omega}$ can be the frequency response of a discrete-time LTI system. | ☐ | ☐ |
| If $x(t)\xrightarrow{FT}X(\omega)$, then $x(t)\cdot\cos(2t+\pi)\xrightarrow{FT}-0,5\left[X(\omega-2)+X(\omega+2)\right]$ | ☐ | ☐ |

Table 6: Examples of test items considered of high difficulty degree.

## 2.2 Final exam

The final exam was the same and was held at the same time for all the students independently whether the student is following or not the continuous evaluation process. It consisted of two parts. The first one had two open exercises with several sections with increasing difficulty. One exercise was devoted to analyze the properties of a continuous time linear and time invariant (LTI) system. i.e. calculating its transfer function and frequency response, and to obtain the output of such a system for a given simple input signal. The other open exercise was dedicated to analyze the properties of a discrete time LTI system. While one of these exercises was presented as a direct problem (the input-output relation or the impulse response of the system was given), the other one was an inverse problem (some properties and values of the frequency response and/or transfer function are known and we ask for the impulse response or input-output relation). In both cases, the problems had unique solutions, although these solutions could be obtained in several ways. Examples of sections of the open exercises problems are given in tables 1, 2 and 3.

The second part of the exam was a true/false test with 16 items that students should classify accordingly. Fails counted negatively for the test score. The sentences were similar to those in tables 4, 5, and 6. Both open exercises and test were agreed by the 7 lecturers.

The time to fulfil the exam was limited to 2 hours for the open exercises plus 45 minutes for the test.

## 3. RESULTS

Figure 1 shows a comparison between the marks obtained by the students in the continuous evaluation process (horizontal axis) and in the final exam (vertical axis). The points that fall on the vertical axis correspond to students that made the final exam but did not follow the continuous evaluation. As the figure shows, there is not a clear linear relation between both marks (represented in the figure by the solid line), which should be if both assessment methods were equivalent. However, there is a patent overall increasing tendency of the final exam marks as continuous evaluation score of the students gets higher.

In general, when comparing two different assessment methods, lecturers are usually worried about these methods resulting in different pass or fail decisions for the same students. These cases could occur when the points fall in the upper left quadrant or in the lower right quadrant of Fig. 1. Lecturers

that defend the final exam are specially worried about the points in the lower right quadrant that represent students with achievements that meet the course requirements but fail in the final exam. For the present case of study, less than 15 % of the students succeeded in the continuous evaluation and failed in the final exam. However, around 60 % of these students obtained a final exam mark higher than 3.5. Therefore, we can conclude that students that pass the continuous evaluation do not usually perform poorly in the finals. On the other side, points that fall in the upper left quadrant of Fig. 1 mainly correspond to students that partially followed the continuous evaluation; that is, during several weeks at the beginning of the semester, and they finally gave up, thus preferring the option of a single final exam for their evaluation.

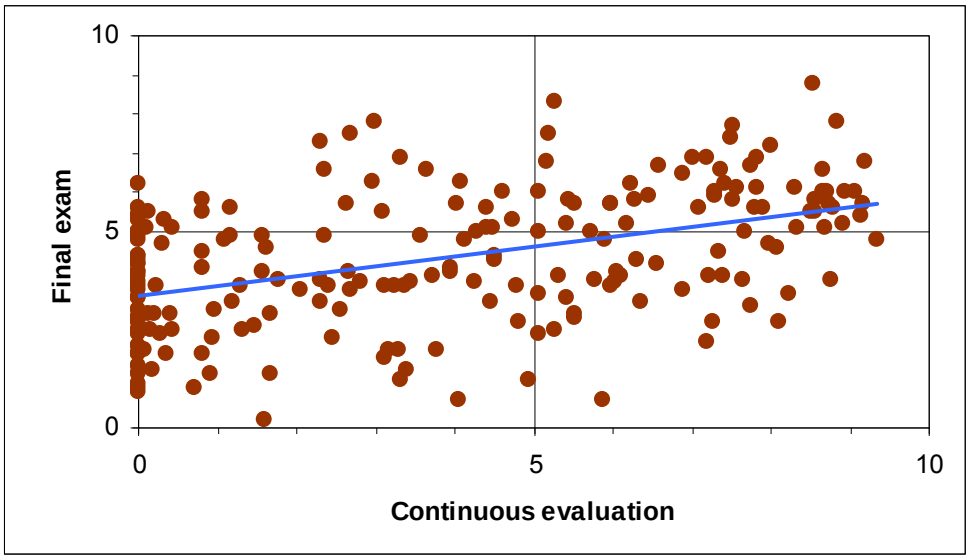



Fig. 1: Final exam marks (vertical axis) versus continuous evaluation marks (horizontal axis). Linear regression has been plotted in blue.

There is another aspect that is interesting from Fig. 1: most of students that obtained marks higher than 2 (quite a low threshold) in the continuous evaluation succeeded in the final exam (57%); in contrast, only 28% of students that obtained less than 2 points in the continuous evaluation passed the final exam. Therefore, it may be inferred that the implemented continuous evaluation method helped the students to prepare the final exam.
Finally, the percentage of students that pass the final exam (independently of their continuous evaluation mark) is practically the same than the percentage of students that pass the continuous evaluation (around 41% in both cases).

## 3.1 Weighting of continuous evaluation and final exam

As stated before, those students that could not attend the normal classroom activities or those that for any reason did not follow the programmed coursework could not be assessed in a continuous way and they were offered an evaluation based on a single final exam. In addition to this, the existence of a final exam is defended by some lecturers because it compels the students to acquire a complete and global view of the whole course. Most of these lecturers also support the idea that this mandatory final exam should have a high weight in the final mark of the student. For this reason, we have studied what could happen in the case that the final mark of the student was obtained by combining the marks of the continuous evaluation and final exam with different combining weights.
Figure 2 shows the comparison of the final exam marks versus a combination of 25% of the continuous evaluation marks plus 75 % of the final exam marks. Obviously, a great correlation is observed. However, the relevant aspect is that the number of students that pass the course with such a combination while failing the final exam is only 6 (less than 3%). Moreover, five of these students failed the exam with a mark higher than 4.5. Possibly due to this reason, many students considered that the programmed activities in the continuous evaluation method are too hard and time consuming and, in contrast, they had little direct impact on the final marks; consequently, they did not follow the continuous evaluation method.

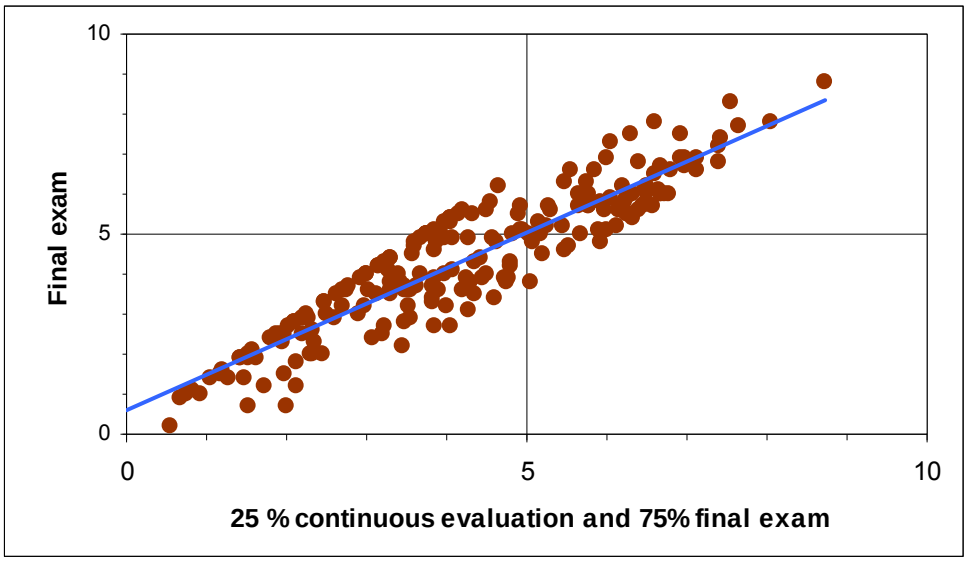



Fig. 2: Comparison of the final exam (vertical axis) marks versus a combination of 25% of the continuous evaluation a 75% of the final exam.

Figure 3 shows the comparison of the final exam marks versus a combination of 75% of the continuous evaluation marks and 25 % of the final exam marks. In this case, there are about 10% of the points that fall in the lower right quadrant of Fig. 3. Only 6 of these (3% of the total) represent students that failed the exam with a mark lower than 3.5 and succeeded with the given combination of the continuous evaluation and final exam. We may conjecture that this is the group of students that may have cheated within the continuous evaluation and did not assimilate the subject under study.

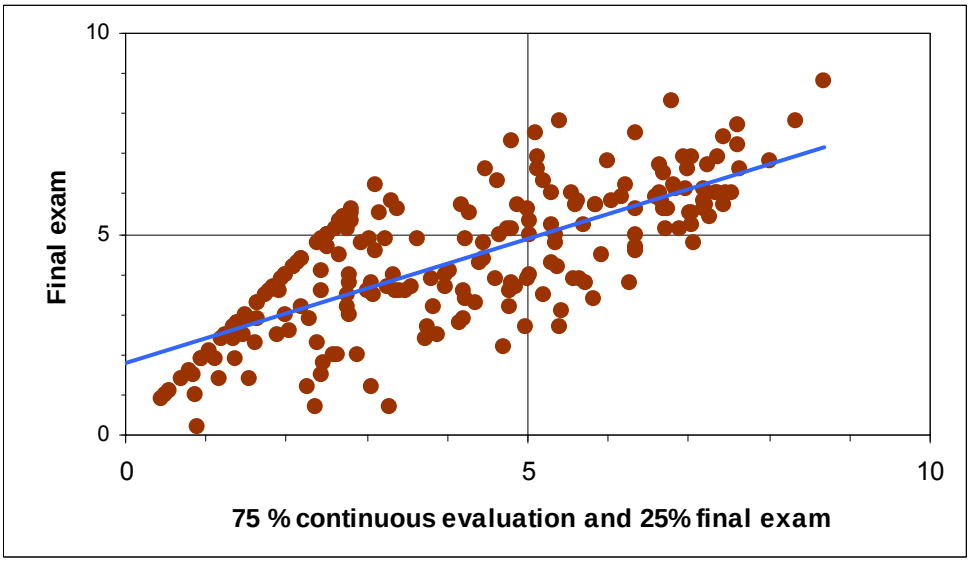



Fig. 3: Comparison of the final exam (vertical axis) marks versus a combination of 25% of the continuous evaluation a 75% of the final exam.

Fig. 4 represents the percentage of students that failed the final exam but would obtain a final mark equal or higher than 5 as a function of the weight given to the continuous evaluation. It can be seen that such percentage is kept very small (below 10%) even when weighting the continuous evaluation as high as 50 %.

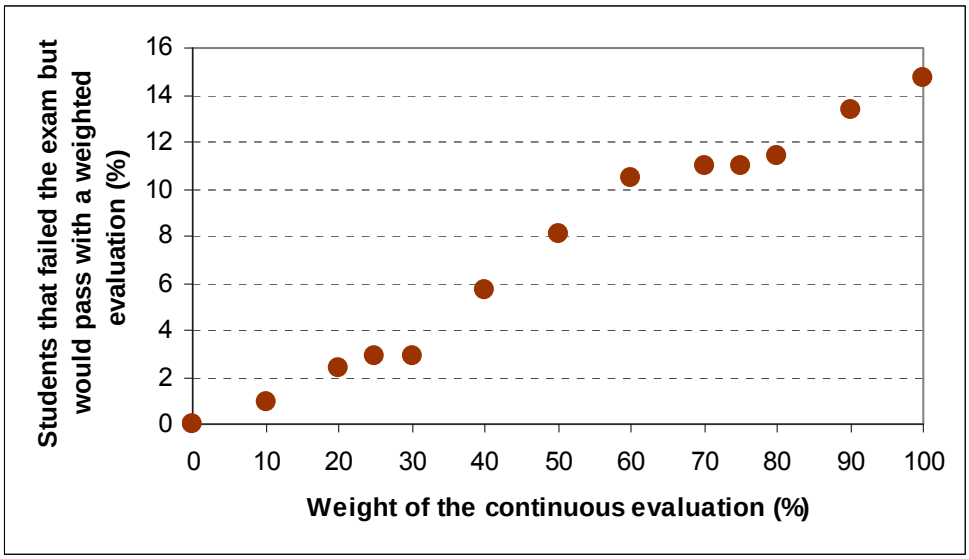



Fig. 4: Percentage of students that failed the final exam but would succeed with a combination of continuous evaluation and final exam marks versus the weight of the continuous evaluation.

## 4. CONCLUSSIONS

In this work we have analyzed the final marks obtained by students when they are assessed by two different methods: final exam and continuous evaluation. We have focused on the binary classification fail (mark lower than 5.0) versus pass (mark equal or greater than 5.0) when either one or the other assessment method is adopted. We have found that more than 70 % of the students were classified in the same group for both assessment methods (points that fall in the lower left and the upper right quadrants of Fig.1). There are a 15 % of students that failed with continuous assessment method (most of them either did not do the coursework or obtained a mark around 4 in the continuous assessment method) but succeed in the final exam. We are not concerned about this group because it can be considered that these students prefer the final exam and succeed. On the other side, 15 % of the students succeed in the continuous assessment but failed the final exam (most of them with final exam marks over 3.5).

From these data, we may conclude that the final exam could be substituted by the continuous evaluation method because the fail/success classification is almost the same. The final exam should be preserved only for those students that, for any reason do not follow the programmed activities in the continuous evaluation. However, we are aware that this conclusion should be taken with caution, since this study had the bias of the students knowing a priori the weight of each evaluation procedure, so the results should be confirmed with other studies in which different weights are set.

Another interesting conclusion is that for the described conditions only 3% of the students seem to have cheated during the continuous evaluation. An easy way of detecting this kind of behavior could be requiring a minimum mark in the self evaluation tests, e.g. that most of the questions that cover the basic part of every chapter should be correctly answered.

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